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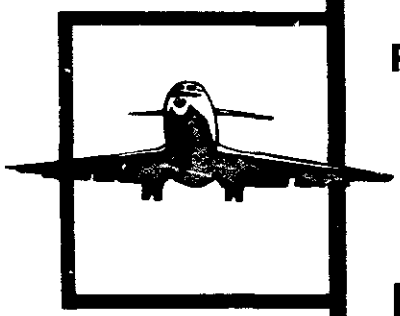
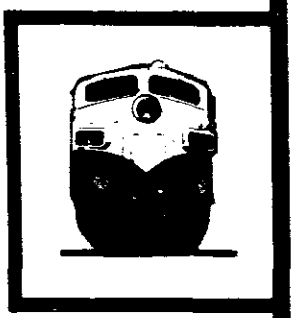
NATIONAL TRANSPORTATION SAFETY BOARD

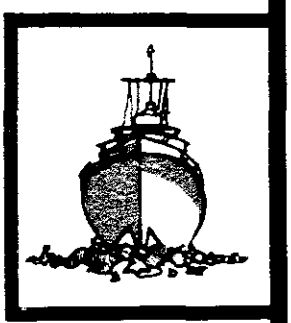
Washington, D.C.

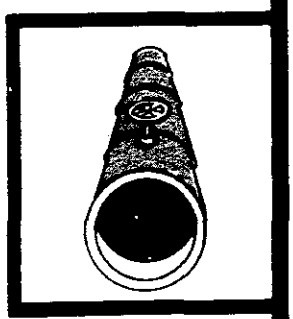
NTSB Safety Study SS-85/02
Air Carrier Overwater Emergency Equipment and Procedures

(26 Pages)









PB85-917006

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY STUDY

AIR CARRIER OVERWATER EMERGENCY EQUIPMENT AND PROCEDURES

NTSB/SS-85/02

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16. Abstract

The chances of surviving air carrier accidents into water would be increased if Federal Aviation Administration (FAA) emergency procedures and FAA-approved survival equipment were improved. Current procedures and equipment are designed on the assumption that air carrier water contact accidents are primarily ditchings, a water accident characterized by at least some preparation time and relatively little aircraft damage. In fact, a review of air carrier water contact accidents between 1959 and 1984 shows that such accidents are typically inadvertent, with no preparation time, substantial aircraft damage, and a high chance of occupant injury. Often the cabin floods quickly, followed by sinking of the aircraft within minutes. Typically, these accidents do not occur on "extended overwater flight" (the type of operation to which most FAA water survival regulations currently apply) but close to an airport, during approach or departure. At least 179 fully certificated airports in the United States are located within 5 miles of a significant body of water. The Board recommended the FAA require both life preservers and flotation seat cushions on all air carrier flights, and asked for improvements in life preserver design, packaging, accessibility, and ease of donning. Other recommendations deal with emergency evacuation slides, liferafts, flotation devices for infants, crew post-crash survival training, and water rescue plans at airports near water.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

SAFETY STUDY

Adopted: June 12, 1985

AIR CARRIER OVERWATER EMERGENCY EQUIPMENT AND PROCEDURES

INTRODUCTION

During the evening of October 22, 1962, a Northwest Airlines DC-7, operating as a military air transport charter flight with 95 passengers and 7 crewmembers aboard, was flying from Tacoma, Washington, to Anchorage, Alaska. While cruising at 20,000 feet, one engine lost power. Remedial measures failed, the propeller oversped, the engine seized and became dangerously hot, and began to shed parts. The captain elected to ditch.

Detailed preparations were carried out during the next 45 minutes. Twenty-eight passengers were moved from the front rows. All passengers and the flight attendants donned life preservers. The children, in special preservers, were distributed strategically in the cabin to optimize the availability of assistance in evacuating them. Seatbacks were raised; the passengers were told to remove all sharp objects from their persons. These, along with loose objects, such as food trays, armrests, and carry-on baggage, were stowed so as not to impede evacuation. Passengers were rehearsed in folding their arms and lowering their heads into pillows, blankets, or coats in their laps, and told to do this on signal, just prior to touchdown. Passengers sitting near emergency exits were told how to open the exits and how to launch the liferafts. Passengers were cautioned not to take any emergency action until advised. Rafts were moved near the exits and their static lines secured to nearby seats.

Having informed the flightcrew that all was ready, the steward used the public address system to tell passengers to assume proper ditching positions and to remain that way until told to get up. The aircraft ditched at approximately 9 p.m. in Sitka Sound, about a mile off Biorka Island. Water contact was smooth. The aircraft slowed and then floated high in a calm sea, with no visible damage other than bent propeller blades. Water temperature was 56 degrees, air temperature, 53 degrees.

The crew immediately began launching the liferafts and assisting passengers into them. Only a few persons were immersed. Water depth in the cabin rose to about 2 feet, but the aircraft did not sink rapidly. Within 5 minutes of ditching, all occupants were in rafts; only 1 did not have a crewmember in command. Within another 20 minutes, all had been transferred to a launch and then retransferred to a Coast Guard cutter, both standing by after being summoned by the aircraft captain before ditching. All 102 occupants were immediately taken to a hospital for observation; none was seriously injured. The aircraft took 24 minutes to sink.

The report of the Civil Aeronautics Board 1/ described this ditching and evacuation as "an outstanding feat" and attributed its success to several factors: "virtually, ideal conditions of wind and sea, crew familiarity with ditching procedures, ample time to ready the flotation equipment and passengers, and finally, the military passengers' receptiveness and responsiveness to orders."

The standards, regulations, and other requirements of the Federal Aviation Administration (FAA) pertaining to passenger transport aircraft and their operation over water might well be appropriate and sufficient if all water impact accidents were similar to the Sitka Sound ditching. In general, the FAA requirements reflect an assumption that the remarkably favorable conditions of this accident are typical of water accidents. Accident experience has shown this premise to be incorrect. Virtually, none of these accidents are "planned" ditchings, as this one was. With possibly one or two exceptions, all of the survivable water impact accidents which have involved transport category aircraft since 1959 have been inadvertent, with no time for crew and passenger preparation--taking seats, fastening seat belts, donning life preservers, bracing for impact, readying liferafts (if available), etc. 2/ Accident data clearly show that in inadvertent, survivable water impact accidents, the aircraft is likely to sustain severe damage, including breakup of the fuselage followed by rapid flooding and probable sinking of the aircraft within minutes; 3/ the occupants probably will have to contend with injuries, panic, rising water, unfamiliar and often inaccessible water survival equipment, and possibly jammed exits. These accidents often occur at night. The crewmembers may themselves be dead or injured and thus may not be able to provide leadership and instruction. Those who succeed in getting out of the aircraft face the dangers of drowning (especially if they have suffered impact-related injuries or are under the influence of alcohol) and often of hypothermia. For those unable to swim, all these terrors are likely to be greater.

This study recommends steps the FAA should take to bring its requirements more in line with the reality of the inadvertent water impact accident, rather than the atypical model of the "planned" ditching (like Sitka Sound), on which the requirements are now largely based.

1/ Civil Aeronautics Board, Aircraft Accident Report: Douglas DC-7C, N285, Northwest Airlines, Inc., Ditching in Sitka Sound, Alaska, October 22, 1962, File No. 1-0030. The National Transportation Safety Board, now an independent Federal agency, evolved from a function formerly performed by the Civil Aeronautics Board.

2/ Dick Johnson, "Study on Transport Airplane Unplanned Water Contact," DOT/FAA/CT-84/3, January 1984 (included in FAA, Water Survival Staff Study: Inadvertent, Survivable Air Carrier Water Accidents, August 1984.)

3/ Ibid.

Fortunately, water impacts by transport category aircraft have been relatively infrequent. Between 1959 and 1979, there were only 16 survivable air carrier water impact accidents worldwide--approximately 10 percent of the total survivable air carrier accidents. 4/ (From 1980 through 1984, there were two other survivable water impact accidents involving U.S. passenger transport air carriers.) Their very infrequency, however, has made it difficult to assemble empirical evidence on the performance of various types of survival equipment, methods of stowage, crew-to-passenger instructions and other critical aspects of post-impact survival in the water. In the environment of an actual inadvertent water impact, critical equipment flaws or lack of adequate crew training may become apparent. There is no way to make a realistic evaluation and test of equipment and training most useful to a panicked, injured person numbed with cold in a rapidly flooding, impact-damaged aircraft, or in rough seas at night. Thus, whatever information can be garnered from survivors of water crashes about real-world performance of equipment and the effectiveness of instruction techniques should be considered carefully for assessing current water survival measures.

The infrequency of water accidents is sometimes cited as a reason for not improving water survival equipment or not requiring that more types of air carrier operations provide survival equipment. Indeed, in a 1984 cost-benefit analysis, FAA staff concluded that current water survival equipment requirements "are adequate for U.S. air carriers" and that "there does not appear to be justification at present for extensive research, development, engineering, or regulatory programs in this area." 5/ However, despite the infrequency of water impact accidents, there are requirements for water survival equipment and crew training, and the aviation community has made a rather substantial commitment to meeting these requirements. The Safety Board believes that to be worthwhile the regulatory requirements should result in the most effective water survival measures feasible.

The following sections of this report will address the current overwater emergency regulations and their relationship to actual emergencies; the need for basic water survival equipment on all transport category passenger flights; the need for additional equipment on all transport category passenger extended overwater flights; improvements needed in emergency equipment, including slides and life preservers; the importance of good training for both cockpit and cabin crews in managing planned ditchings and inadvertent water impacts (with emphasis on the latter); and the need for more water rescue planning at airports near water.

4/ FAA, op. cit.
5/ Dr. Leslie E. Eder, "Cost-Benefit Analysis, U.S. Air Carrier Accidents Terminating in Water (1954-1983)," April 9, 1984 (included in FAA, op. cit.).

BASIC REGULATORY DEFICIENCIES

A basic problem with the current water survival-related regulations is that they focus primarily on ditchings 6/ occurring at sea on "extended overwater" flights.7/ However, as mentioned previously, virtually all survivable water impact accidents are inadvertent. Furthermore, a review of accidents involving overwater air carrier operations shows that survivable overwater accidents (in which water played a role in the fate of the occupants) have occurred either closer to shore than 50 nautical miles or in some body of water, such as a lake or river. Most have occurred near an airport, during approach or departure. 8/ In recognition of this, the Board believes a number of steps should be taken to redirect and conform regulatory requirements with the actual circumstances and risks involved in overwater air carrier operations under 14 CFR 121, 125, and 135.

Need for Basic Water Survival Equipment on All Passenger Air Carriers

All air carrier aircraft which operate under 14 CFR 121, 125, or 135 operations should be required to carry certain basic water survival equipment:

6/ "Ditching" is not defined in the Federal regulations. It usually means a planned event in which the flight crew, with the aircraft under control, knowingly attempts to land in water. In contrast to an inadvertent water impact, in which there is no time for passenger or crew preparation, ditchings allow some time for donning life preservers, etc. 14 CFR 25 sets crash performance standards for aircraft to be certificated for "ditching" and requires "ditching"-certificated aircraft to have liferafts and life preservers. The section in 14 CFR 23 on liferafts and life preservers is termed (like its counterpart in Part 25) "ditching equipment." The sections of 14 CFR 91 dealing with "large and turbine powered multiengine airplanes" limit their water survival equipment requirements to those thought useful in water accidents far from shore (at least 50 miles out for certain equipment, either 30 minutes or 100 miles out for other equipment), and the sections refer explicitly only to "ditchings." 14 CFR 121 sets equipment requirements for both "extended overwater" flight and for "any overwater" flight, but the requirements for the latter are minimal; 14 CFR 125 and 135 have no requirements for water survival equipment except for "extended overwater" flight.

7/ "Extended overwater" flight is defined in 14 CFR 1.1 as flight "over water at a horizontal distance of more than 50 nautical miles from the nearest shoreline."

8/ Out of 37 "water impact events" between 1959 and 1979, there were 11 that the FAA staff study considered survivable and in which the water played a key survival role. Most occurred during the approach/landing or takeoff/departure phase of flight, most very near the airport (the most distant occurred 30 miles from shore). FAA, op. cit. The two U.S. water impact accidents between 1980 and 1984 both occurred during takeoff or landing, very near the airport.

approved flotation seat cushions and, for each occupant on board (including infants), an approved life preserver. 9/ As discussed below, the Board considers this equipment to be essential when overwater operations are involved. The FAA staff study found that at least 179 fully certificated airports in the U.S. are located within 5 miles of a body of water of at least one-quarter square mile surface area (certificated airports in Alaska were not included, although a high percentage are near water). Virtually all aircraft used by Parts 121, 125, and 135 operators use one or more of these 179 airports (or may need to use one of them in an emergency). Thus, many passengers are exposed to risk of inadvertent water impact near an airport, whether or not their flight is classified as an "extended overwater" flight.

Need for Life Preservers.--Despite inadequacies in the current FAA Technical Standard Order (TSO) C13d for life preservers (which are discussed below), they are distinctly superior to the only other inflatable personal flotation device now permitted by FAA rules, the inflatable "individual flotation device" (IFD) described in TSO-C72b. For example, adult life preservers have at least 21 more pounds buoyancy than inflatable IFDs; and no donning tests are required for inflatable IFDs, as they are for current life preservers. The Safety Board believes all aircraft operating under Parts 121, 125, and 135 should be equipped with approved life preservers, and that inflatable "individual flotation devices" (TSO-C72b) no longer should be permitted as alternatives.

Need for Flotation Seat Cushions.--Flotation seat cushions, despite their drawbacks, should be required on all air carrier airplanes being operated under 14 CFR 121, 125, or 135. It is true that seat cushions must be held by the user--a formidable task for children, other small persons, and those who may be injured, and an impossibility for infants or unconscious persons. Furthermore, even when correctly held, seat cushions tend to tip the user backward. However, in the most common type of water accident, inadvertent impact with fuselage breakup and cabin flooding, flotation seat cushions may be likely to break free and float to the surface and, possibly, offer the only ready means of flotation available to survivors. For example, after the inadvertent crash of an Antilles Air Boat near the U.S. Virgin Islands in September 1978, some seat cushions floated free and were used by some of the survivors. Even though these were not flotation cushions, had no handholds, and became quite slippery in the water, they provided the only flotation assistance available, since no liferafts were on board and no one was able to retrieve the life preservers stowed under each seat. By providing

9/ The Board recommended (A-84-20) in March 1984 that the FAA "require the installation of TSO-C13d life [preservers] on all [Part 121] air carrier aircraft [by January 3, 1986]." The Board recommended in June 1979 (A-79-36) that the FAA "require that all passenger-carrying [Part 121] air carrier aircraft be equipped with approved flotation-type seat cushions." The Board recommended in August 1979 (A-79-67) that the FAA "require that all aircraft conducting passenger service under Part 135 in any overwater operation be equipped with approved flotation-type seat cushions" and that on extended overwater flights these aircraft carry approved life preservers. All three recommendations remain open at this time.

the only flotation assistance available, since no liferafts were on board and no one was able to retrieve the life preservers stowed under each seat. By providing a relatively accessible means of flotation in the immediate aftermath of an accident, flotation seat cushions may keep some survivors afloat who are unable to retrieve and don life preservers or board a raft; in other cases, they may provide enough flotation aid to allow some survivors to retrieve the life preservers (for themselves, perhaps for others) and/or deploy liferafts, slide/raft combinations, or evacuation slides used as flotation platforms, where those are available.

If life preservers and flotation seat cushions come to be required on all aircraft operating under Parts 121, 125, and 135, the sections of those Parts dealing with predeparture oral briefings should be amended to require, on all flights, appropriate information on the availability and location of these devices. 10/

The Special Needs on "Extended Overwater" Flights

The problems faced by survivors of a water impact far from shore may be different from those close to shore; it is reasonable to assume that survivors far from shore may not be rescued for some time, and hypothermia is an almost certain hazard. The FAA staff study notes that "the civilian aviation community underestimates the consequences of an accident involving cold water immersion and the effects that hypothermia could have on survival probabilities." For persons injured and/or in shock, there are few bodies of water warm enough to not present the risk of hypothermia; many would induce hypothermia even in uninjured, strong adults. The rapid onset of hypothermic symptoms in the survivors of the Air Florida crash into the Potomac River in January 1982 was evident. The first officer of the World Airways DC-10 that overran the runway at Boston's Logan International Airport that same month was in the water less than 10 minutes while he swam to shore; he was "shaking uncontrollably" as he climbed the bank and fell on the ground several times before being assisted. The captain also had to be carried to an ambulance when he reached shore; a flight attendant, also in the water less than 10 minutes, required hospitalization for hypothermia.

To minimize the risk of hypothermia, it is essential that as much of the body as possible be gotten out of the water as quickly as possible--ideally, keeping the entire body dry altogether but, at the least, minimizing the time any part of the body is immersed in water. Since life preservers cannot provide whole body thermal protection (as a wet suit would, for example), it is all the more important that all air carrier aircraft operating on extended overwater flights carry additional flotation equipment on board that can protect against water immersion, whether it be liferafts, slide/raft combinations, or modified evacuation slides.

Current regulations require that aircraft being used on Part 121, 125, or 135 extended overwater flights carry "approved liferafts." (Most wide-bodied aircraft use "slide/raft combinations" to meet this requirement.) The FAA staff study

10/ The Safety Board is currently preparing a Safety Study on methods used to present safety information in predeparture briefings.

discussed a number of problems with liferafts (not including slide/raft combinations) that make them "of questionable value under any condition, but particularly in the inadvertent case where preparation time is non-existent and immediate fuselage rupture and flooding is probable." In these situations, the study contends, "the probability of anyone remaining behind to retrieve and deploy this equipment . . . is virtually zero." 11/ An alternative means of filling this need, the door-mounted slide/raft combination, which automatically deploys outside the aircraft when the door is opened in the armed position, is a major advance in this area. The Safety Board supports efforts to develop alternatives to liferafts and believes that the FAA should continue research and development to improve equipment that protects the whole body.

In the meantime, however, liferafts and/or slide/raft combinations are the only means available to obviate prolonged whole body immersion. The current requirements for the survival tools (knife, various ropes, canopy, food, etc.) required to be carried on these devices are set out in two TSOs and three sets of operating rules, and there are significant differences among them. For example, the operating rules for extended overwater flight under Parts 125 and 135 require a substantial number of survival tools not required under Part 121 and not required by either TSO-C70a (for "life rafts") or TSO-C69a (for "slide/rafts"). The TSO for "life rafts" requires a somewhat different set of survival tools from those required by the TSO for "slide/raft combinations" (even though slide/raft combinations are permitted on wide-bodied aircraft to meet the "approved life raft" requirement). The FAA should determine exactly what tools are needed for all extended overwater flights and standardize the requirements in the TSOs and the operating rules.

Need to Upgrade Evacuation Slides

Most wide-body aircraft are equipped with slide/raft combinations; thus, at all times they are capable of providing the means to prevent whole body immersion. Most narrow-body aircraft, however, are not equipped with slide/raft combinations 12/ and are required to carry liferafts only on extended overwater flights.

Since water impact accidents occur primarily during the takeoff or landing phases of flight, not during the "extended overwater" phase, and are not limited to aircraft equipped with slide/raft combinations, it is important that the evacuation slides on narrow-body (and, where still used, on wide-body) aircraft be modified to offer a means to avoid immersion.

11/ FAA, op. cit.

12/ The Board recommended in June 1972 (A-72-65) that the FAA expedite development of the slide/raft combination and make mandatory its installation "on all U.S. air carrier aircraft at an early date." (Emphasis added.) This recommendation was closed in October 1972. In its report on the National Airlines crash into Escambia Bay, Florida, in May 1978, the Board noted that installation of slide/raft combinations had not yet been accomplished on narrow-body aircraft "as has been done for the wide bodied aircraft."

The FAA's Civil Aeromedical Institute (CAMI) developed and tested some design improvements of the evacuation slides currently used on narrow-body aircraft, including addition of inflatable "outriggers" (primarily to increase the capacity of the slides when used as a raft) and modification of the slides' attachment to the airplane to make it easily and quickly releasable from the airplane ("quick-release girts"). 13/ The results of these experiments are encouraging. The FAA should continue these developments and issue standards for modifications as they are proven and regulations requiring operators to use improved evacuation slides that will provide the means to avoid water immersion on new and existing aircraft on which full slide/raft combinations are not installed.

In the meantime, the Safety Board believes that where evacuation slides are required, they should at least include handholds and quick-release girts. Although these modest changes may not be sufficient to render these evacuation slides adequate to preclude immersion following an inadvertent water impact, they would render the slides far more useful as flotation platforms.

PROBLEMS WITH CURRENT LIFE PRESERVERS AND INFLATABLE "INDIVIDUAL FLOTATION DEVICES"

The Safety Board has issued many recommendations during the past 15 years for improvements in life preservers and inflatable IFDs. The major problems with these safety devices have been in the areas of stowage, packaging, sizing, donning, ability to maintain user's upright position, and tendency to channel water into the user's face. None of these problems has yet been satisfactorily resolved.

Life preservers still are made to the same basic design as the "Mae West" preservers used by military airmen. However, the "Mae West" devices were intended (although not required) to be worn at all times during flight.14/ The same basic designs now are being provided to air carrier passengers (including children) for extended overwater flight; but these devices must be found, unstowed, unpackaged, donned, and inflated. Under the best of circumstances, having to perform all these procedures will make it more difficult to realize the benefits of these devices. Under the actual conditions of a ditching—much less an unprepared, inadvertent water impact—these many steps seriously undermine the potential effectiveness of these water survival devices. Therefore, it is extremely important to simplify each of these steps as radically as possible, minimizing the time, thought, and dexterity needed to carry them out successfully.

13/ The CAMI report on its modifications and testing of evacuation slides notes, at the outset, "Suggestions have been made to modify the evacuation slides carried aboard narrow-bodied aircraft by. . . adding lines or nets that could provide hand holds." However, the Institute's modifications did not, apparently, include handholds. E.A. Higgins, G.E. Funkhouser, and J.T. Saldivar, "Progress on the Water Survival Program," October 1983, in FAA, op. cit. Lack of handholds was one of the items stressed by survivors of the Overseas National Airways accident (near St. Croix in May 1970) as having impeded use of the ONA slides as flotation platforms.

14/ FAA, op. cit.

Problems with Stowage

Life preserver stowage is addressed in various ways in the FAA regulations. Taken together, these regulations require that each life preserver have its own stowage compartment, that a stowed life preserver be within easy reach of each seated occupant, that it be easily accessible in a ditching without appreciable time for preparatory procedures, that the stowage compartment be conspicuously marked and be approved, and that the stowage compartment protect the life preserver from inadvertent damage.15/

Despite the requirements for life preserver accessibility, users repeatedly have had difficulty retrieving life preservers from their usual stowage location, under the seat. Such difficulties contributed to the deaths of several of the 23 people who died in a May 1970 crash near St. Croix (Overseas National Airways operating as Antilles Air Boats--Antilliaanse Luchtvaart Maatschappij). The passengers spent the 5 to 7 minutes between being told of a possible ditching to the moment of impact trying to retrieve their life preservers from under the seats, unpackage them, and get them on. Some had to get down on their hands and knees to open the stowage compartment; others never could get the compartments open. In the 1978 Antilles Air Boats crash mentioned earlier, none of the life preservers stowed under the seats was retrieved. In a National Airlines crash into Escambia Bay, Florida, earlier that year, the passengers "had difficulty extracting" the life preservers from under the seats. In this accident, "rising water in the cabin compounded the problems of locating and removing the vests from the underseat compartments." Crewmembers and some able-bodied passengers eventually had to swim under water through the aisles, retrieve as many preservers as possible and then attempt to distribute them to passengers already outside the aircraft and help them put them on.

Many passengers involved in the World Airways runway overrun at Boston in 1982 "had problems retrieving the [preservers] from under their seats." Many passengers involved in the Eastern Air Lines L-1011 near-ditching offshore at Miami, Florida (May 5, 1983) also reported having "problems locating the life vest stowage compartment" and many "had difficulty removing the life vest package from the stowage compartment."

These retrieval problems were confirmed in timing tests at CAMI conducted in 1983. 16/ Adult test subjects tried a total of 50 times to retrieve a life preserver from under their seats; the times to complete this task successfully ranged from 9 seconds to 80 seconds (average: 17 seconds). Timed tests also were made of retrieving life preservers from an experimental location in the back of the seat ahead, but with only slightly better results. In tnese tests, retrieval

15/ There is no indication whether "inadvertent damage" is intended to include crash-induced damage, and if so, at what levels of force.

16/ It should be remembered that all of these tests were conducted with uninjured adults, in a well-lighted area, with no injuries, no panic, no rising water, no damage to the stowage area, no onboard baggage obstructing the area; they had received their instructions as to stowage location and stowage compartment operation in a calm atmosphere, giving it their full attention. None of these conditions is likely in a real inadvertent water impact.

times in 50 trials ranged from 7 seconds to 39 seconds (average: 14 seconds). Furthermore, 24 of the 50 test subjects unfastened their seat belts in order to retrieve the life preservers from under the seat; 14 of the 50 did so to retrieve them from the seat back. Although releasing the seat belt would not be dangerous in an inadvertent water impact (by the time life preserver retrieval is undertaken, the aircraft would have already impacted, and belts would no longer be needed), it would present a danger to passengers preparing for a "planned" ditching, who might then forget or no longer have time to rebelt before the moment of impact.

When life preservers are stored under the seats, they are vulnerable to entrapment or damage resulting from floor disruption and/or seat collapse that are typical in inadvertent water impacts. The preservers may be ejected from their compartments and lost in the general litter of carry-on baggage, galley equipment, etc., as happened in the SAS accident at JFK Airport in February 1984. Life preserver retrieval from underseat stowage locations can also be affected adversely by the increasing size and amount of carry-on baggage now being regularly jammed under seats and on the floor around seats. 17/ Clearly, current stowage arrangements still present real problems in quick and easy retrieval of life preservers.

Eastern Air Lines employs a new stowage location for life preservers on their Boeing 757 aircraft: in a separate overhead compartment in the passenger service units. This location may overcome the problems of crash damage to the equipment and inaccessibility due to rising water. Because many passengers may need to stand (and therefore unfasten their seat belt) to retrieve the preserver from this location, it may exacerbate the problem of passengers being unrestrained in a planned ditching.

The Board believes the current regulations that address stowage of life preservers should be revised to preclude stowage in locations vulnerable to water impact damage to the fuselage, seat collapse, or cabin flooding. Insofar as possible, given different types of cabin designs in aircraft operated under Parts 121, 125, and 135, a standard stowage location should be used.

Problems with Packaging

Life preserver packaging has been a problem for a long time. In the 1970 Overseas National Airways (ONA) crash referred to earlier, passengers who finally were able to retrieve their life preserver from under their seat (or obtain one

17/ For example, see "Emergency Equipment and Carry-On Baggage, Interim Report," prepared by a special FAA NATI team during late 1984: "It should be emphasized that . . . all flight attendants, crewmembers, and agents contacted readily admitted that carry-on baggage is out of control. . .On numerous observations, carry-on baggage under seats has protruded so far into the leg room area that the passengers had . . . to place their feet on top of the items. Likewise, many articles were observed that only fit part way under the forward seat. . . The sheer volume of articles placed on the floor would create serious hazards in an actual emergency situation."

from another passenger or a crewmember) experienced considerable difficulty in opening the plastic protective cover. One said he had to use his pocket knife to open the cover. Packaging also impeded passengers' access to life preservers after the National Airlines crash into Escambia Bay, 8 years later. Four years after that, only one life preserver on the Air Florida Boeing 737 that crashed into the Potomac was retrieved by survivors of the impact. The flight attendant who opened and inflated this one for a seriously injured passenger said it was "extremely difficult" to open the package. She finally opened it "by chewing and tearing at it" with her teeth. Of course, in this case the extreme cold of the water made this task even more difficult, since all survivors said "they quickly lost most of the . . . use of their hands."

That same month, passengers on the World Airways DC-10 at Boston said "they had difficulty opening the plastic packing of the vests." One flight attendant said she had to use her teeth to tear the cover open. A year and a half later, during the near-ditching of an Eastern L-1011 off the coast of Miami, a significant number of passengers said they had "problems removing the life [preserver] from the sealed plastic packages." In general, "the passenger comments about life [preservers, including] the removal of the [preservers] from the plastic pouches. . . were negative."

There is no evident reason the packaging problems noted above cannot be reduced or eliminated. Packaging and donning of life preservers should be evaluated and tested together, the timed test beginning with a fully packaged preserver (not an unpackaged one, as is now the case). Time spent attempting to open an ill-designed package would be time unavailable for the rest of the procedure—actually donning and adjusting the device. All packaging designs, those supplied by the preserver manufacturer, the operator, or the overhaul facility, should be required to be demonstrated to be in compliance with the timed donning test.

Problems with Donning

Beginning with the ONA crash off St. Croix in 1970, the Safety Board has been urging the FAA to make improvements in the requirements for life preservers to make them easily and quickly usable in the actual environment of a water impact. In the ONA crash, despite two demonstrations of life preserver donning and considerable individual assistance from the crew, the passengers continued to have difficulty donning their life preservers. Most took their seatbelts off and stood up while trying to get their life preservers on, and at least five forgot to refasten their seatbelts and were thus unrestrained at the moment of impact.

In the 1983 Eastern L-1011 near ditching near Miami, the passengers again had difficulty donning the life preservers. Although repeated donning demonstrations were carried out by flight attendants during the ditching preparation, some passengers found they could not put on their preservers while seated with their seatbelts fastened; some of the flight attendants therefore told them to unfasten their seatbelts and stand up to facilitate getting the life preservers on. Some flight attendants later said they had to assist passengers into their life preservers after the passengers had become "tangled" in the devices. Parents trying to help their children into life preservers had particular difficulty, since the preservers have to be donned differently by a child.

After the 1970 ONA crash, the Board had recommended (A-71-33) that the FAA reassess the standards for life preservers, "with a view toward eliminating the deficiencies. . .as evidenced by. . .this accident."18/ After more detailed analysis of that crash, the Board recommended (A-72-64) that the FAA consider revising the then-current TSO on life preservers to call for "more comfortable, standardized, and less complicated life [preservers] for use in air carrier aircraft."

After the National Airlines crash in 1978, the Board urged the FAA (A-79-39) to expedite its work on revising the TSO and "eliminate the difficulties identified in this accident with respect to the packaging, donning, and operation of life [preservers] by uninstructed subjects under stress." 19/ After the 1983 Eastern L-1011 near-ditching, the Board recommended (A-84-19) once again that the FAA initiate research to guide it in revising the life preserver TSO to "require that life preservers. . .can be donned in a minimum time by the average passenger without assistance while seated with the lap belt fastened."20/

Life preservers certified under the "old" life preserver standard, TSO-C13c, were not required to meet any performance standard for donnability; as a result of Safety Board recommendations, the FAA issued TSO-C13d in January 1983, that includes a requirement that "an adult . . . can don [it] within 15 seconds unassisted while seated" and that "an adult can install [it] on another adult, a child, or an infant within 30 seconds."

This additional requirement apparently has had little effect on the donnability of life preservers, however. In fact, tests carried out by CAMI on four life preservers certified under the earlier TSO-C13c showed that, of the 100 persons involved in the tests, only 1 was able to get it on completely and correctly within 15 seconds (starting with the unstowed, unpackaged life preserver in hand and with seatbelt fastened). After TSO-C13d was issued, CAMI again ran donning tests on the same four life preservers tested earlier; by now, these four designs, unchanged in any way, had been certified under TSO-C13d. These tests were conducted in the same way as the earlier tests, except that the subjects were instructed to unfasten their seatbelts before beginning the donning process (as discussed earlier, a dangerous situation for passengers preparing for an imminent ditching).

Of 100 attempts to don the preservers under these favorable conditions, only 4 were successfully completed within 15 seconds (these 4 attempts involved only 2 of the 4 life preservers being tested). In 72 attempts, successful donning took between 15 and 55 seconds. In 3 attempts, the users took between 1 and 2 minutes to complete donning. In 21 attempts, the users either did not don their life preservers correctly within 2 minutes or stopped trying for a 15-second interval (so these attempts were counted as failures).

18/ This recommendation was closed in June 1972.

19/ TSO-C13d, the current life preserver TSO, was the result of the ONA recommendation (A-72-64) and the National Airlines recommendation (A-79-39). In reviewing the FAA's proposal for this TSO, the Board suggested that the packaging requirements could be improved. Although they were not, the Board closed both recommendations in October 1983.

20/ This recommendation remains open at this time.

As of this writing, the FAA is considering possible revisions to TSO-C13d to address life preserver donning. The changes under consideration of which the Board is aware thus far, however (through informal staff discussions), will not be sufficient to solve the donning problems commonly experienced in tests and in real world accidents.

CAMI reports that for adults the life preservers' adjustable waist straps appear to be the major problem in correct donning. Users fail to tighten the straps, or do not fasten them correctly, or do not fasten them at all; furthermore, users of all four life preservers commonly ended up with twisted waist straps jammed in the strap length adjusters. Beyond these problems, users were confused by the many straps, the various types of attachment mechanisms, which was the top of the device and which the bottom, whether it was supposed to be put on like a vest/jacket 21/ or over the head, involving similar time-consuming deliberations.

These donning problems need not be an inherent characteristic of life preservers, however. At the same time these four life preservers were tested, CAMI also tested two devices modified from so-called "angler's vests." These experimental devices, are not permitted by current FAA regulations requiring "life preservers," since "life preservers" must have two inflation chambers and the "angler's vest" has only one. However, the device proved to be much simpler for users to don than the certified life preservers. Of the 50 persons using one of the two "angler's vests," 29 were able to get it on completely and correctly within 15 seconds. The average donning times ranged between 16 and 17 seconds—compared to an average donning time for the four TSO-C13c life preservers between 28 and 38 seconds, and for the four TSO-C13d preservers, between 21 and 37 seconds. (However, it should be noted that the average TSO-C13d donning times were calculated after eliminating the worst tests, thereby reducing the average times to some extent.) CAMI attributed the superior performance of the "angler's vests" to several factors "that result in minimal ambiguity as to their correct use": they both look like a vest and are in fact intended to be donned like a vest (unlike preservers, which look a bit like a vest but are not intended to be donned like one); they have an obvious front-to-rear position on the body; and there are no straps to contend with, just a large-tooth plastic zipper up the front. 22/

Currently, to demonstrate to the FAA that a life preserver meets TSO-C13d's donning standards, the manufacturer need only demonstrate that "an adult" can don it within 15 seconds, unassisted and seated, and that "an adult" can put it on another adult, a child, or an infant within 30 seconds. The Board believes these

21/ The devices used on board aircraft are commonly referred to as "life vests" or "life jackets," even by the FAA, the airlines, and the Safety Board—a practice which tends to reinforce the misconception that these devices are really like a vest or jacket and should be put on in the same manner.

22/ Other possible improvements of current life preserver designs to render them more easily donnable include use of a single waist strap with a simple, standardized adjustment clasp. This alternative reportedly offers the possibility of easy and inexpensive retrofit of existing preservers.

standards to be wholly inadequate. Only an adult's ability to don it or put it on another adult need be tested; a child's ability may be substantially less, as might an adult's ability to put it on an infant. More important, TSO-C13d requires that only one adult need successfully don the preserver to demonstrate compliance, and there is no limit on the number of adults who may be tested in order to find one who passes the test. (In fact, there really is no explicit prohibition against asking the same adult to try repeatedly until successful.)

The donning test requirements should stipulate the minimum number of persons to be tested in each group test; a minimum and maximum number of group tests that may be performed; a minimum percent of persons in each group who must pass in order to count the group test a success; and the minimum number of group tests that must be successful. Furthermore, the composition of each test group should be required to be reasonably representative of air carrier passengers in terms of age and sex; at least one child and one infant should be included in at least one group. No person should be included in the test who has experience in donning life preservers.

It is highly desirable that the design of life preservers permit them to be easily donned in the water. The FAA staff study notes that survivors of inadvertent water impacts generally "exit the aircraft immediately." In the cases the FAA reviewed in which life preservers were on board, "a few survivors. . . retrieved underseat life preservers," but "most of these individuals . . . exited the aircraft before donning the vest." Thus, if these survivors were ever to be able to don their life preservers, they would have to do so in the water. The CAMI tests have demonstrated amply that traditional life preserver designs make donning extremely difficult for many people even when they are sitting or standing, uninjured, in a non-stressful setting. These difficulties almost certainly are increased for people attempting to put them on in the water. However, life preservers of simpler, vest-type design (with no straps to find, adjust, fasten, untangle, etc.) are likely to be easier to put on in the water than are the traditional type.

Furthermore, on current life preservers and IFDs, the instructions for use are printed on the device itself--usually in such a way that the words are either upside down or in back when the device is donned. The correct donning procedure for "angler's vests," on the other hand, is more obvious, and they probably would need only minimal donning instructions or none at all.

The fact that there are at least 5 different models of life preservers in use today also may contribute to the commonly experienced donning problems. Even passengers who pay careful attention to and understand the cabin crew's donning instructions may be bewildered in attempting to don the preserver that is under their seat if it turns out to be of a different design. In revising its standards for life preservers, the FAA should seek to promote standardization of design. 23/

23/ The International Federation of Airline Pilots Associations recently proposed that a world-wide standard design be developed.

Given the evident donning superiority of modified "angler's vests," their further development should be encouraged by the FAA. Life preservers need to be designed to require a minimum of thought and manipulation; designers of these devices should strive to create a life preserver whose correct donning is self-evident. Experience shows that many passengers ignore or pay little attention to flight attendants' pre-flight oral briefings and life preserver demonstrations, do not read safety cards, and do not watch videotaped safety briefings. Even those who pay careful attention to these instructions may not be able to remember the instructions when they need them, particularly under the real conditions of an accident and the severe stress that most people experience in those circumstances. In several accidents the Board has investigated, passengers needed extensive "hands-on" help from the flight attendants, in some cases despite repeated donning demonstrations. The evidence is that, in the real world, a substantial proportion of the people who need to put a life preserver on will have to do so without benefit of much instruction.

The Board believes that the best single way to provide to life preserver manufacturers the needed incentive to maximize simplicity of design and reduce the need for instruction is to require that the TSO-C13 timed donning test be performed without the use of an information card, a donning demonstration, or any other instruction in correct donning procedure. Although this concept may at first appear unduly rigorous, the Board believes that this stipulation would in fact only partially balance the enormous advantage enjoyed by donning test participants over people in actual water accidents. Donning test participants perform under minimal, if any, stress; they are unhurt, not in imminent danger of drowning or immersion in frigid water, not surrounded by injured and frightened fellow passengers. They are working in a well-lighted area. The life preserver is not hopelessly jammed under the seat by excess carry-on baggage or a collapsed seat. Importantly, they are given correct donning procedures only moments before undertaking the task of donning --little time elapses in which to begin to forget the instructions.

People faced with the task of donning a life preserver after a real accident are not so fortunate. Since the conditions of a timed donning test cannot begin to simulate the difficult conditions of a water impact accident, it is necessary to use surrogate measures that may help to balance the unrealistically positive conditions of the test. The best single surrogate measure for this purpose is the elimination of donning instruction. If this is a condition of the certification test, manufacturers will find it necessary to move toward life preserver designs whose correct donning is readily apparent. This one feature will substantially enhance the usefulness and effectiveness of life preservers. The current regulations and standards should be modified to promote their development and permit their use, and to discourage use of current devices.

Problems with Sizing

Sizing also remains a difficult problem in life preserver design. Although it is possible to adjust traditional life preserver designs to fit a range of body sizes, they are not satisfactorily sized for small children or infants; furthermore, changes in size for adults must be accomplished through adjusting strap lengths--for many people, a tricky procedure that ends in failure with

tangled, twisted, misconnected straps and attachments. Although the "angler's vest" originally was made and tested in only three sizes, the Board understands that CAMI has developed a modification of the vest that is said to fit a wide range of body sizes (except infants) by means of expansion panels.

Because life preserver sizing is such a difficult problem in the case of infants and very young children, and more importantly, because life preservers cannot provide sufficient protection against perhaps the deadliest survival threat to these persons—hypothermia—the FAA should require that individual flotation devices be designed specifically to provide whole body protection of infants (younger than 2 years). 24/ More than 15 years ago, CAMI tested a prototype infant flotation device which resembled a covered basket and was constructed with thermal materials. Although questions have been raised about the feasibility of this device (would an infant become too hot inside? might he/she suffocate?), the Board believes the concept is worth pursuing to see if these are real drawbacks and, if so, whether they can be overcome.

Need for Survivor Locator Light on Life Preservers

Finally, all life preservers carried on board transport category aircraft should be required to be equipped with an automatically activated survivor locator light. The Board recommended this in 1963, after a Lockheed Constellation operated by the Flying Tiger Lines was ditched in the North Atlantic in September 1962 with 76 persons aboard. Several survivors had reported that it was difficult, without life preserver lights, to locate other survivors in the darkness and high seas. However, the current TSO for life preservers does not require automatic survivor locator lights; it requires only that they have lights if the regulatory Part under which the aircraft is being operated requires them to have lights. Since life preservers are required only on Part 125 or 135 flights classifed as "extended overwater," life preservers that may be provided on other flights need not have survivor locator lights. It seems illogical to the Safety Board to permit the carriage of life preservers that do not have lights. Lights are likely to be needed in any water impact situation in which life preservers are needed; therefore, it seems appropriate to revise the TSO governing the design of all life preservers, to require lights rather than to allow variations dependent on the applicable operating rules of the Federal Aviation Regulations.

The Board believes that the FAA should more vigorously seek the active engagement of life preserver manufacturers in the search for solutions to the current deficiencies in life preservers. Manufacturer participation in the process of improving life preserver design, developing suitable preservers for infants, and eliminating packaging problems should be sought well before proposed changes to the standards are drafted.

24/ Many aircraft operating under Part 121 may not carry even a regular "infant" life preserver, since even on "extended overwater" flights, they need carry only one preserver for each "occupant"; infants often are not considered "occupants" since they often do not occupy a seat by themselves. This may change with the increasing number of parents using child safety seats, which involves the child occupying a passenger seat.

CREW TRAINING

The behavior of the cockpit and cabin crewmembers in preparing for a ditching, or in the immediate aftermath of an inadvertent water impact, can have a significant effect on the chances for survival of those passengers (or other crewmembers) not killed by the water impact. Many factors combined to make the Northwest Airlines DC-7 ditching in Sitka Sound, Alaska so successful; among these factors was the excellent coordination between the flightcrew and the cabin crew and competent performance by both crews in preparing the passengers for ditching and helping them after the ditching. On the other hand, in the 1970 ONA ditching off St. Croix, the Board found that "the passengers were prepared inadequately. . .due to insufficient. . . time, inadequate briefings, insufficient training [of the crew], and lack of proper crew coordination." The Board's special report on this crash stated, "The most important single factor in occupant survival during ditchings is proper preparation and control of the passengers by the crew," and cited accident investigation reports by the Civil Aeronautics Board (CAB) and the National Transportation Safety Board, and a CAB special study. 25/ The report went on to say, "It appears that close crew coordination and detailed crew guidelines are the main ingredients necessary to successful completion of this task." The FAA staff study in 1984 concluded that crew training in "quick response procedures following inadvertent water contacts" is needed, "in addition to, or in place of, the planned ditching training given by most carriers."

As a result of the ONA crash, the Board recommended that the FAA "require periodic crew training in evacuation and wet ditching drills" and that "all air carriers make a critical review of their crew training practices and materials. . . [to expand] their training in. . .crash survival and crew leadership and [ensure] adequate retention of such knowledge" (A-72-71 and A-72-73). 26/

The crew of the National Airlines B-727 that crashed in Escambia Bay, Florida, performed courageously and intelligently in the aftermath, helping passengers evacuate the rapidly flooding cabin, swimming through the cabin and diving under the water to retrieve life preservers, helping injured persons get on top of the fuselage to await rescue, and swimming among the survivors to distribute life preservers and to help passengers don them. Their performance was important in minimizing the loss of life in the crash.

In the Eastern Air Lines L-1011 near-ditching in 1983, the flightcrew did not communicate adequately with the cabin crew, so that flight attendants had no idea how much time they would have in which to get the passengers ready for the ditching. When the senior flight attendant tried to find out why the airplane was returning to Miami a few minutes after takeoff, she was told to leave the cockpit; a short time later, she was called back. When she opened the door, the flight engineer told her, "prepare the cabin for ditching" and then he closed the door.

25/ Civil Aeronautics Board, op. cit.; Civil Aeronautics Board, Aircraft Accident Report: Flying Tiger Line, Inc., Lockheed 1040H, Ditching in the North Atlantic Ocean, September 23, 1962, Docket No. 367; NTSB, Aircraft Accident Report, Pilgrim Aviation and Airlines, Inc., DeHavilland Turbo Prop DHC-6, Long Island Sound, February 10, 1970 (NTSB-AAR-71-1); Civil Aeronautics Board, A Study of United States Air Carrier Water Accidents, July 1954 - June 1964.

26/ Neither of these recommendations was acted on by the FAA; both are now closed, the first "unacceptable action," the second, "no longer applicable."

She was given no further information. Based on this inadequate information, she had to assume the ditching was imminent, so she and the other flight attendants helped passengers get their life vests on as quickly as possible and moved able-bodied passengers to positions near exits. After some time, the flightcrew announced over the PA system that ditching was imminent; the senior flight attendant therefore immediately instructed all cabin occupants to assume the brace position. Ten minutes later, with all cabin occupants still in the brace position, she decided to try to get further information from the cockpit. She opened the cockpit door and the flight engineer told her to "prepare for a normal landing." At the same time, the captain made the same announcement to the passengers over the PA system. As a result of that incident, the Board recommended (A-84-17) that the FAA require Eastern Air Lines to revise its flight manuals and flight attendant manuals to address the evident problems of crew communications. 27/ The Board also recommended (A-84-18) that the FAA require its operations inspectors to review and require modification as needed of all air carriers' flight and flight attendant manuals and of their training programs, to preclude similar types of communication problems in other carriers' operations. 28/

The Board believes that improvements in crew training and procedures manuals are needed, to ensure that both flightcrew members and flight attendants are thoroughly versed in the location and operation of all water survival equipment to be found on any aircraft operable under Parts 121, 125, or 135. (Other recommendations made in this report, whose acceptance by the FAA will increase the standardization of flotation devices on air carrier aircraft, will make the task of crew training easier and enhance crewmembers' retention of their safety training.) Crewmembers should be trained effectively and be required to demonstrate, initially and periodically throughout their careers, that they are knowledgeable in the use and proficient in the handling of all water survival equipment on board the aircraft. The FAA should identify and require the additional emergency procedures and training needed for all crewmembers to be able to perform well in an inadvertent water impact.

AIRPORT WATER RESCUE PLANNING

Following the crash of an Air Florida Boeing 737 into the Potomac River near National Airport in January 1982, the Safety Board recommended that the FAA review the adequacy of water rescue capabilities at certificated airports "having approach and departure flightpaths over water" and make recommendations for improvement "as necessary to appropriate airport authorities." (A-82-88) The Board also recommended that the FAA amend Part 139 to require "adequate water rescue capabilities at [certificated] airports having approach and departure

27/ Based on the FAA's response, Board staff has recommended that the recommendation be closed.

28/ Based on an Air Carrier Operations Bulletin dated July 2, 1984, that "requests" Principal Operations Inspectors to carry out such a review, the Board closed this recommendation on November 16, 1984.

flightpaths over water" and ensure that these capabilities "are compatible with the range of weather conditions which can be expected." (A-82-89) The FAA reported in February 1985 that it had completed the survey; publication of proposed revisions of Part 139, delayed several times since 1982, is now anticipated in "early 1985."

In its report on the World Airways runway overrun at Logan International Airport 10 days after the Air Florida crash, the Board noted that the FAA's Advisory Circular (AC) 150/5210-13 "goes beyond regulatory requirements and suggests that the emergency plans, facilities, and equipment at airports include the capability for water rescue for all conditions which might be encountered," and stated that "the FAA should make mandatory the guidance provided in" that Advisory Circular.

The FAA staff study recommended that the FAA amend Part 139 to require the provision of "water rescue capability at certificated airports with potential water hazards," including that "water hazards had to be under normal approach or departure flight paths." The staff study recommended further that the revision should include a requirement for semi-annual evaluation by airport operators of the water rescue capability, including staging of a simulated disaster to evaluate "typical winter and summer [water rescue] conditions." The study also recommended the promulgation of an Advisory Circular to urge operators of noncertificated airports near water to take similar actions.

In proposing revisions to Part 139, the FAA should address the need to define a "significant" body of water and a perimeter around an airport within which the presence of such bodies of water will require the development of a water rescue plan; the Board's recommendation that the guidelines in AC 150/5210-13 be mandated; and the several related recommendations in the FAA's own staff study.

CONCLUSIONS

1. "Planned" ditchings of passenger transport category aircraft are extremely rare.

2. Inadvertent water impact accidents, though far more common than ditchings, also are infrequent; those that are survivable usually involve severe aircraft damage, occupant injuries, rapid flooding of the cabin, and sinking of the aircraft within a short time.

3. Current Federal Aviation Administration water survival equipment and training requirements are geared to survival in the event of a ditching and assume that adequate preparation time will be available.

4. Most survivable inadvertent water impacts have occurred closer to shore than 50 nautical miles, near an airport, on approach or departure.

5. There are at least 179 fully-certificated airports in the United States with significant bodies of water within 5 miles; flights that involve use of these airports present a risk of inadvertent water impact, even if the flight is not classified as "extended overwater" or "any overwater."

6. Airports near significant bodies of water, even those that are fully-certificated, are not required to develop plans for handling water impact accidents of aircraft approaching or departing from the airport.

7. Current regulations addressing water survival equipment unjustifiably provide different levels of safety for flights operating under Parts 121, 125, and 135.

8. Flotation seat cushions alone are insufficient as water survival equipment on any flight being operated under Part 121, 125, or 135; however, they are useful supplements to other equipment (life preservers, slide/raft combinations, modified evacuation slides).

9. Despite several revisions of the standards for life preservers, there still are serious problems involving stowage accessibility, packaging, sizing, donnability, and performance in the water.

10. If suitably modified to accommodate a wider range of body sizes, the "angler's vest" appears to be a substantially more desirable personal flotation device than traditional life preservers, because of its simplicity of donning.

11. No realistic provision has been made for water survival equipment (including hypothermia protection) for infants and small children.

12. Flotation devices obviating whole body immersion are important items of survival equipment for extended overwater flights; those types that can be easily deployed (slide/raft combinations, modified evacuation slides) also are important on other flights in which inadvertent water impact is a potential danger.

13. Evacuation slides could be useful as "flotation platforms" if they were modified to be quickly and easily detachable and had handholds; there is reason to believe they could even be modified to obviate whole body immersion in a manner reasonably similar to life rafts and slide/raft combinations.

14. The ability of flight and cabin crewmembers to assist passengers effectively during ditchings and following inadvertent water impacts may be the single most important factor in the survival outcome.

15. Crewmembers' ability to assist effectively in water accidents could be improved by better training and requirements for demonstrations of continued proficiency in handling survival equipment; joint flight crew/cabin crew "wet" evacuation drills not only would help meet these goals but also would promote better coordination in carrying out their respective duties.

RECOMMENDATIONS

As a result of its Safety Study on Air Carrier Overwater Emergency Equipment and Procedures, the National Transportation Safety Board recommended that the Federal Aviation Administration:

> Amend 14 CFR 121 to require that all passenger-carrying air carrier aircraft operating under this Part be equipped with approved life preservers meeting the requirements of the most current revision of TSO-C13 within a reasonable time after the adoption of the current revision of the TSO; ensure that 14 CFR 25 is consistent with the amendments to Part 121. (Class II, Priority Action)(A-85-35)

> Amend 14 CFR 125 to require that all passenger-carrying air carrier aircraft operating under this Part be equipped with approved life preservers meeting the requirements of the most current revision of TSO-C13 within a reasonable time after the adoption of the current revision of the TSO; amend Part 125 to require approved flotation-type seat cushions (TSO-C72) on all such aircraft; ensure that 14 CFR 25 is consistent with the amendments of Part 125. (Class II, Priority Action)(A-85-36)

> Amend 14 CFR 135 to require that all passenger-carrying air carrier aircraft operating under this Part be equipped with approved life preservers meeting the requirements of the most current revision of TSO-C13 within a reasonable time after the adoption of the current revision of the TSO; amend Part 135 to require approved flotation-type seat cushions (TSO-C72) on all such aircraft; ensure that 14 CFR SFAR No. 23 is consistent with the amendments to Part 135. (Class II, Priority Action)(A-85-37)

> Amend 14 CFR 25 and SFAR No. 23 to require that the stowage compartment for life preservers be located where the life preserver will not be susceptible to water impact crash damage or to cabin flooding; amend 14 CFR 121, 125, and 135 to be consistent with the amendments to Part 25 and SFAR No. 23 and to require compliance within a reasonable time after adoption of the amendments to Part 25 and SFAR No. 23. (Class II, Priority Action)(A-85-38)

> Amend the relevant sections of 14 CFR 121, 125, and 135 to require that all pre-departure briefings include a full demonstration of correct life preserver donning procedures. (Class II, Priority Action)(A-85-39)

Determine the items of equipment, including survival tools, needed on liferafts and slide/raft combinations, and standardize the now-differing requirements for these items variously specified in 14 CFR 121.339, 125.209, 135.167, TSO-C70a, and TSO-C69a. (Class II, Priority Action)(A-85-40)

Amend TSO-C69a to require quick-release girts and handholds on emergency evacuation slides; amend 14 CFR 121 and 125 to specify a reasonable time from the adoption of the revision of the TSO by which all transport passenger air carrier aircraft being operated under these Parts must be equipped with slides conforming to the revised TSO. (Class II, Priority Action)(A-85-41)

Amend TSO-C13d to require that the timed donning tests include the time to extract the life preserver from an unopened package. (Class II, Priority Action)(A-85-42)

Amend TSO-C13d to establish specific donning test performance requirements and compliance criteria, based on accepted statistical sampling practices that, at a minimum, set a lower limit on the number of persons to be used in each group test; upper and lower limits on the number of group tests that may be performed; the minimum percentage of persons in each group who must pass the test in order to count the group test a success; the minimum number of group tests that must be successful; and the composition of each group, including a requirement that only naive subjects be used. (Class II, Priority Action)(A-85-43)

Amend TSO-C13d to require that the timed donning tests be performed without the use of a briefing card or a donning demonstration. (Class II, Priority Action)(A-85-44)

Amend TSO-C13d so that it does not preclude the use of single inflation chamber life preserver designs that otherwise meet the requirements of the TSO. (Class II, Priority Action) (A-85-45)

Amend TSO-C13d to require an automatically activated survivor locator light. (Class II, Priority Action)(A-85-46)

Amend TSO-C13d to require that donning and/or use instructions printed on life preservers must be demonstrated to be readable when the preserver is donned. (Class II, Priority Action)(A-85-47)

Amend TSO-C13d to provide specific minimum performance standards for flotation devices designed to meet the needs of infants, including whole body protection from

hypothermia; amend 14 CFR 121, 125, and 135 to require that a specific number of approved infant flotation devices, meeting the requirements of TSO-C13 as amended, be carried within a reasonable time on all passenger-carrying air carrier aircraft operating under these Parts. (Class II, Priority Action)(A-85-48)

Amend relevant emergency training sections of 14 CFR 121, 125, and 135 to require the cockpit and cabin crewmembers on aircraft being operated under these Parts be given periodic training, including "hands-on" "wet" drills, in the skills relevant to inadvertent water impact which may increase the chances of post-crash survival. (Class II, Priority Action)(A-85-49)

Also, the Safety Board reiterated the following recommendation to the Federal Aviation Administration:

Amend 14 CFR 121.340 to require that all passenger-carrying air carrier aircraft be equipped with approved flotation-type seat cushions. (A-79-36)

The Safety Board placed the following recommendations to the Federal Aviation Administration in a "Closed--Superseded" status:

Amend 14 CFR 135 to require that all aircraft conducting passenger service under Part 135 in any overwater operation be equipped with approved flotation-type seat cushions, and to require aircraft conducting extended overwater operations to also be equipped with an approved life preserver equipped with an approved survivor locator light. (A-79-67)

Revise 14 CFR 121 to require the installation of TSO-C13d life vests on all carrier aircraft within 12 months of the effective date of TSO-C13d. (A-84-20)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. Goldman
Vice Chairman

/s/ G.H. PATRICK BURSLEY
Member

June 12, 1985

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